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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 94.

B. T. GALLOWAY, *Chief of Bureau.*

FARM PRACTICE WITH FORAGE CROPS IN WESTERN OREGON AND WESTERN WASHINGTON.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 19, 1906.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 94 of the series of this Bureau, the accompanying manuscript, entitled "Farm Practice with Forage Crops in Western Oregon and Western Washington."

This paper was prepared by Mr. Byron Hunter, Assistant Agriculturist, under the direction of the Agriculturist in charge of Farm Management Investigations and in cooperation with the State agricultural experiment stations of Oregon and Washington. Provision has been made for publication by these two experiment stations.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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FARM PRACTICE WITH FORAGE CROPS IN WESTERN OREGON AND WESTERN WASHINGTON.

INTRODUCTION.

Although the average methods in farm practice in any region are usually far below the highest possibilities, men are to be found here and there who have worked out the problems of crop production and utilization in a satisfactory manner and who stand out as the most successful farmers in their respective communities. By studying the methods of a large number of such men it is possible to acquire a large amount of valuable information that would require years of patient labor to glean from personal experience. During the three years the writer has had charge of forage plant investigations in the Pacific Northwest, considerable time has been spent in the Willamette Valley and the region of Puget Sound studying the methods of the farmers most successful in growing and handling forage crops. In addition to the information obtained in this detailed study, much has been gleaned during thirty years' residence in the Pacific Northwest, including nine years' residence in the Willamette Valley. This bulletin is a result of this study, and the material herein contained, except as noted in the text, is based almost entirely upon the information obtained in this manner.

For the benefit of the readers of this bulletin not familiar with the condition under which the crops discussed are grown a brief description of the region is given. Although much has been published regarding the superiority of legumes over other plants as soil renovators and food for farm animals, there are many into whose hands this bulletin is likely to fall who do not understand the importance of this group of plants. For this reason a paragraph is given upon the nature of these plants and the methods of their inoculation. For similar reasons the principles underlying haymaking and the use of hay caps are discussed.

DESCRIPTION OF THE REGION.

What is said in these pages is applicable to all that region west of the Cascade Mountains in Oregon and Washington as far south as the upper portion of the Willamette Valley. With the exception of some of the mountainous areas the winters are mild. The summer months are comparatively dry, the nights are cool, and dews are frequent and heavy. The annual rainfall varies from about 20 inches in a small area where the Strait of San Juan de Fuca joins Puget Sound to more than 100 inches at several points along the Pacific coast. The main body of agricultural land about Puget Sound has an annual rainfall of 30 to 60 inches; that of the Willamette Valley 40 to 50 inches.

The average rainfall of this region for six years is shown in the following table:

Average monthly and annual rainfall at points in the States of Oregon and Washington.

Month.	Oregon.			Washington.		
	McMinnville.	Albany.	Salem.	Olympia.	Seattle.	Bellingham.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
January	7.04	5.48	6.15	8.25	3.93	3.34
February	6.38	6.22	4.17	7.08	4.57	2.69
March	5.71	5.06	4.61	5.17	3.26	2.72
April	3.25	2.41	4.07	4.32	2.38	2.64
May	2.04	1.47	3.42	3.06	2.03	2.52
June	1.15	.74	1.47	2.09	1.87	2.02
July	.53	.57	.28	.55	.82	1.14
August	.81	.82	.65	.68	.68	1.43
September	1.97	1.85	1.94	2.91	2.13	2.26
October	3.39	2.29	3.62	4.24	3.05	2.51
November	10.13	7.44	8.18	10.98	5.77	4.93
December	4.47	6.17	6.62	7.92	5.13	3.85
Yearly	46.87	40.52	45.18	57.25	35.62	32.05

It will be seen that the rainfall is light during summer, heaviest during winter, and quite well distributed throughout the remainder of the year. With its mild winters and abundant rainfall the region as a whole is exceedingly well adapted to forage plant production. Grasses remain green during the entire year, while the clovers, vetches, root crops, rape, and kale, with proper care, all yield abundantly.

In Oregon the Willamette Valley constitutes the major portion of the agricultural land of the region studied. When first brought into cultivation the valley soil was friable, easily tilled, and productive. For years the cereals were practically the only crops grown, and much of the land at the present time is still producing these crops exclusively. The average yield of wheat on such land at the present time is said to be as low as 10 or 12 bushels per acre. Formerly it was much higher. The growing of cereal crops year after year has

depleted the soil of much of its humus and rendered it heavy, lifeless, and difficult to work. Applications of barnyard manure and the growing of leguminous crops bring the soil back to its proper texture and fertility, and since dairying and live-stock production have become such important industries in the valley much of the land is being rapidly restored to its former productiveness.

Western Washington is largely covered with a dense growth of evergreen timber and underbrush. The prairie land is limited and much of it is gravelly and of little agricultural value. Most of the agricultural land was formerly timbered, and it has shown itself eminently adapted to the production of forage crops and various kinds of fruit. Clover has been one of the leading crops for years, and little of the land has been subjected to the exclusive production of cereal crops. As might be expected, therefore, most of the farm land of western Washington is still in a very productive condition.

HAYMAKING.

To make hay of prime quality west of the Cascade Mountains is often a difficult matter. Most of the hay crops, if allowed to mature naturally, are ready to cut during the month of June, while the late spring rains are usually not over until the 1st of July. Thus, haymaking would naturally occur at a time when good weather can not always be relied upon. Even when the weather is fair the nights are cool and dews are frequent and heavy. This difficulty is often partially overcome by pasturing the meadows in the spring until about the 1st of May to retard the development of the crop, so that haymaking will occur after the late spring rains are over.

CONDITIONS GOVERNING STAGE AT WHICH HAY SHOULD BE CUT.

There are several factors to be considered in determining the proper stage at which a crop should be cut for hay. Chemists tell us that hay made from young growing plants is more digestible and contains more protein per pound than hay made from more mature plants. If hay is cut early the percentage of protein is greater; if cut later, the percentage of protein is less, but the yield of dry matter in pounds is materially increased. As an illustration of this, see the table giving the amount of dry matter in corn at different stages of development, page 29. The protein content of hay made from the true grasses, such as timothy or orchard grass, is always low, and the gain in protein per pound from cutting such hay early is always more than counterbalanced by the loss in dry matter. On the other hand, hay made from some of the leguminous plants is said to be too rich for certain classes of animals. Men who have had considerable experience in feeding vetch and alfalfa hay generally agree in saying

that either is too strong a feed for horses, especially if cut very green. For this reason hay made from leguminous crops is frequently cut much riper if for horses than when intended for other animals.

Laxative feeding stuffs are undesirable for horses, but not for cows. Green hay is laxative in character, while hay cut in a more mature condition has an opposite tendency. The stage at which hay should be cut, therefore, will depend upon the class of animals for which it is intended.

The number of times a meadow is to be cut during a season is another factor in the time for cutting hay that must not be overlooked. If there is to be but one cutting, the greatest yield will be secured by allowing the crop to become quite well matured before it is cut. When two cuttings are to be made, farmers who have tried the experiment find that the greatest yield is secured by cutting the first crop while it is still green and growing and before the dry season has begun. The ordinary hay plants are not inclined to continue their growth after the first cutting if allowed to stand until their seed is pretty well formed. A delay of only a few days in cutting the first crop of the season often seriously affects the growth of the second.

A statement of the time for cutting will be found under the special discussion of each crop.

CURING HAY.

The best hay is made without rain and with the least possible amount of sunshine. If it were possible to cure hay in the shade, the quality would be much better. The curing of hay is a process of drying and of fermentation. Hot sun tends to stop fermentations which produce hay of good quality.[a]

From what is said above it is evident that hay should remain in the swath only until dry enough to be raked evenly into windrows; that most of the curing should take place in the cock rather than in the swath or windrow; and that, just as quickly as it is safe to do so, it should be placed in the stack or mow. With fair weather and hot sun, light crops may be raked soon after mowing, often in two or three hours. Heavier crops, especially when green, require more time. When the growth is heavy the swath is often packed so closely to the ground from its own weight and the pressure of the wheels of the mower that the use of the tedder is necessary to dry it out evenly.

West of the Cascade Mountains hay is generally put up in permanent cocks, where it remains for a week or ten days. If it is to remain in the field but a short time some farmers cure it quickly by first putting it into small, flat cocks. In about twenty-four hours these are turned over, allowed to air, and three or four of them are then made into one permanent cock. At what stage hay should be stacked is a question upon which there are many opinions. A com-

[a] W. J. Spillman, in "Farm Grasses of the United States."

mon rule with many farmers is to stack when juice can not be twisted out of a wisp of hay taken from the middle of the cock.

As stated, the common practice in this region is to let hay remain in the field for about a week; in fact, a very large majority of farmers think good hay can be made in no other way under the climatic conditions west of the Cascade Mountains. There are some successful men, however, who put up hay by what has been termed the "rapid process." With good haying weather the method is about as follows: The grass is cut in the afternoon. Being unwilted, the first night's dew does not injure it. If the crop is heavy the tedder is started the next morning as soon as the dew has dried off, and the hay is gone over as many times as possible during the day. Just before evening it is raked and cocked. The hay then stands in the field for two nights and a day and until the dew is off the second day. The cocks are then scattered and aired, especially the bottom portions of them, and the hay is hauled to the mow during the day. It thus requires three days from cutting to hauling. The hay is scattered evenly in the mow so that it may all settle alike and exclude as much air as possible, and is salted at the rate of 10 pounds per ton. At night the barn is tightly closed to keep out damp air.

HAY CAPS.

When the price of hay is high, it is quite probable that hay caps can be used profitably in making hay west of the Cascade Mountains. The use of caps would prevent the outside of the cocks from becoming too dry, and would thus add to the total weight of cured hay. The quality of the hay would be greatly improved, for it would be practically uniform throughout. The use of caps would also greatly increase the certainty of saving the crop. A farmer in Georgia has used hay caps for ten years. He thinks they materially increase both the quality and the quantity of his hay. Unfortunately there are at present no hay caps on the market. However, they may be made of light canvas or any strong cotton cloth in sizes to suit. Caps $4\frac{1}{2}$ to 5 feet square, with pegs or weights attached to hold them in place when in use, ought to give satisfactory service. A coat of oil should be applied to one side of the cloth. The caps should always be dried after being used, for they will mold if piled up wet.

THE SILO.

That the silo should have a very general use in western Oregon and western Washington, not only for the preservation of corn but for many other crops as well, ought to be apparent from an understanding of the climatic conditions of the region. As previously stated, most of the hay crops are ready to cut during the month of

June, while spring rains frequently continue until about the 1st of July. (See table giving the distribution of rainfall on page 8.) It will thus be seen that haymaking ordinarily occurs at a time when good weather can not always be relied upon. If meadows are pastured during the spring to retard the development of the crop, so that haymaking will occur after the late spring rains are over, the yield of the second crop is usually much lighter, since its growth is confined entirely to the dry season. By the use of the silo, on the other hand, the first crop may be cut for ensilage early in June, even though the weather be unfavorable for haymaking. If cut at this time, while the plants are still growing vigorously, a good second crop will usually mature for hay early in August—the best haying season of the year. A light third crop can be used for pasture or cut for ensilage late in the fall. It is evident, therefore, that the use of the silo will practically insure the saving of the first crop, increase the total yield per acre, and cause the second crop to mature at a time when good haying weather can usually be relied upon.

That all kinds of ensilage should be finely cut may be desirable, but we must not get the idea that it is essential. For years ensilage of the finest quality has been made in western Oregon and western Washington out of whole clover and grass (timothy, English ryegrass, etc.). In making ensilage of this kind, however, there are two essentials—an air-tight silo and great care in filling it.

Farmers who use the silo as indicated above agree that the first crop of grass and clover should be cut for ensilage from the 1st to the 15th of June, for the earlier the first crop is cut the greater will be the yield of the second.

Difficulty is usually experienced in raking up freshly cut green grass with an ordinary hayrake. Some farmers avoid this difficulty by cutting with a self-raking reaper or a mower with a buncher attachment. These bunches are then thrown on a wagon by hand. Others cut with an ordinary mower and load from the swath with a hay loader. The heavy green grass often bends the teeth on the elevator bars of the loader. The teeth may be reenforced by nailing blocks of wood on the elevator bars just back of the teeth.

In filling the silo the material must be evenly spread and thoroughly tramped, so that all of the air possible will be excluded. If this is not done much of the ensilage will spoil. Two principal methods were found in use by farmers in filling silos. In the first the freshly cut grass is dropped directly into the silo with a hayfork. Two men in the silo spread the material and tramp it thoroughly, especially around the edges. The center of the silo where the loads from the fork fall requires but little tramping. The second method is to drop the material upon a platform at the top of the silo by means of hay

slings or a hayfork. A man upon the platform throws the material into the silo, placing it as best he can. Another man spreads it evenly in the silo and tramps it thoroughly. This is perhaps the safest method, for there is less chance to slight the work. For a few days after the silo has been filled, the settling of the material will allow the addition of two or three loads each day, each load being thoroughly tramped when added. When the filling is completed the top is covered about 1 foot deep with marsh grass or other waste material that will pack closely and exclude the air. This is wetted thoroughly and tramped daily for several days, using about 2 barrels of water at each wetting. The writer has seen ensilage of excellent quality made from whole grass in this way. He has also seen ensilage made by dropping the material into the silo without spreading and tramping that was practically a total loss.

THE NATURE OF LEGUMINOUS PLANTS.

Plants that produce their seed in two-valved pods, such as peas, beans, vetch, and alfalfa, are called legumes. The value of this family of plants as soil renovators has long been recognized, but in just what way they are capable of restoring fertility to the soil has not been understood until recent years. If the roots of a leguminous plant be carefully removed from the soil little lumps, called nodules or tubercles, will usually be found upon them. These nodules vary in size with different legumes and may be found alone or in clusters. On the roots of red clover they are about twice as large as the seed of that plant. The nodules are caused by bacteria that are parasitic in the roots.

By the aid of the bacteria living in the nodules, leguminous plants are enabled to assimilate atmospheric nitrogen. Since nitrogen constitutes approximately four-fifths of the atmosphere this family of plants has an inexhaustible supply of this important plant-food element. Other plants can not assimilate the nitrogen of the atmosphere; they can obtain it only from decaying organic matter and from commercial fertilizers containing nitrogen. Chemical analyses show the tisues of leguminous plants to be very rich in nitrogen; hence the value of these plants when plowed under as green manure. The roots of a clover crop ordinarily contain more nitrogen than the whole crop removes from the soil. As these roots decay, the plant food in them becomes available for other plants. Nitrogen is usually the first element of plant food that needs renewing; hence the great value of leguminous plants as soil renovators.

Generally speaking, the nodules of each kind of legume are caused by certain kinds of bacteria. Thus there is one kind for alfalfa, another for red clover, another for common vetch, and so on. At

any rate the nodule-forming bacteria of red clover, for example, have become so accustomed to that plant that they are of little or no value in forming nodules on the roots of most other legumes. If nodule-forming bacteria are not in the soil no nodules will be formed; the failure of leguminous crops is often due to this cause. These bacteria may be artificially supplied in two ways, namely, by means of pure cultures of the bacteria and by transferring soil from one field to another. For further information regarding these two methods, see page 24. See also Farmers' Bulletin No. 240, U. S. Department of Agriculture.

FORAGE CROPS.

In the pages that follow, only those crops are discussed that have an important place in the agriculture of the region. What is said regarding methods of seeding, culture, and feeding these crops is based almost entirely upon the farm practice of the region.

RED CLOVER.

Considering the region as a whole, red clover (*Trifolium pratense*) is easily the leading forage plant west of the Cascade Mountains. It thrives best on rich, well-drained upland soils. Many of the low lands that are too wet and cold for red clover become adapted to it when properly drained. If allowed to develop naturally, this crop matures for hay early in June. Rains are not infrequent at this season of the year, and it is a common practice to pasture red clover in the spring until about the first of May to retard the development of the crop, so that haymaking will occur during good weather. Red clover begins to grow in the early spring and, unless the soil is very poor and the summer very dry, remains green and furnishes excellent pasture until early in December.

Generally speaking, red clover reaches its highest development on the coast and the region about Puget Sound, where, under favorable conditions, it may be cut three times during the year. To give three crops it must be grown on rich lands and must not be pastured in the early spring. The first crop should be cut for hay or ensilage early in June, the second for hay in August, and the third for ensilage late in the fall. In the Willamette Valley difficulty is often experienced in getting red clover established, especially on land that has produced cereal crops exclusively for years. This difficulty is probably due to the methods of seeding, the dry summers, the poor texture of the soil, the lack of available nitrogen, and possibly the lack of nodule-forming bacteria. Red clover also frequently runs out in a short time. It is believed by farmers that this is due to the ravages of the clover root borer. In spite of these difficulties, how-

ever, red clover is one of the leading forage plants of the Willamette Valley. It is not unreasonable to assume that these hindrances to the growth of red clover are largely responsible for the important place that common vetch occupies in the agriculture of western Oregon.

In the Willamette Valley it is a common practice to apply land plaster to clover in the spring, during March and April. From 40 to 60 pounds per acre applied on the surface of the ground in the early spring are said to double the yield of both hay and seed. Land plaster has the same effect when applied to other leguminous crops in this region, but it is essential that it be applied early enough to receive an abundance of rain.

METHODS OF SOWING.

There are many methods in use for sowing red clover in western Oregon and western Washington, some of which are given below:

(1) *Clover with early-sown winter wheat.*—From 8 to 12 pounds of clover seed per acre are sown in the early fall with winter wheat on land that has been summer fallowed or from which an early cultivated crop has been removed. The seed is usually sown broadcast and covered with a harrow. If the clover fails to catch it can be sown again in the spring, about the 1st of March.

(2) *Clover with late-sown winter wheat.*—Early in the spring, about the 1st of March, when the ground is heaving slightly from alternate thawing and freezing, from 8 to 10 pounds of clover seed per acre are sown broadcast on late-sown winter wheat. If the ground is dry enough when the clover seed is sown it may be covered with a harrow.

(3) *Clover with spring oats or wheat.*—With this method a good seed bed is essential. The land should be plowed deep in the late fall or winter, and as soon as in good working condition in the spring it should be cultivated until it is in perfect tilth. If the soil is inclined to run together it may be necessary to replow in the spring. Instead of plowing in the fall or winter it may be done in the early spring and the seed bed prepared immediately. After drilling in a full crop of oats or wheat, from 10 to 12 pounds of clover seed per acre are sown and covered with a harrow. In western Washington this is the usual method, with the exception that either timothy, English rye-grass, or orchard grass is usually sown with the grain and clover. On wet land alsike clover often forms a part of the mixture.

(4) *Clover alone.*—When clover is sown alone in the spring the land is plowed early and worked down fine. About the 1st of May it is again thoroughly cultivated to kill weeds and prepare the seed bed. From 10 to 12 pounds of clover seed per acre are then sown

and covered by harrowing. The clover may be pastured during the first season, but should not be cropped too closely during the driest part of the summer. This is becoming quite a popular method in the Willamette Valley and very satisfactory stands are secured, but the use of the land is almost lost the first year.

Clover may be sown alone also in the late summer or early autumn. Although this method is seldom used it is probably one of the most satisfactory ways of sowing clover west of the Cascade Mountains. If sown with grain in the fall, clover does not make a crop the next year, but if sown alone in the late summer a full crop is secured the next summer. It is essential, however, that the seeding be done early, for if sown in the late fall it is liable to be winterkilled. Only crops, then, that can be removed early should precede clover sown in this way.

(5) *Clover with rape.*—Sowing clover with rape is a very successful and popular method with many farmers who are engaged in raising sheep and goats. With the land prepared as indicated for sowing clover alone in the spring, from 10 to 12 pounds of clover seed and from 2 to 4 pounds of rape seed per acre are sown broadcast about the 1st of May and covered with a harrow. If the ground is rough and cloddy, it should be finished with a roller. If this mixture is sown on a thoroughly pulverized and compact seed bed, the rape develops rapidly and furnishes excellent pasture for sheep, goats, calves, or swine in from six to eight weeks. The tramping of the animals while feeding during the summer, principally on the rape, forms a dust mulch on the surface of the ground. In this way soil moisture is retained for the use of the clover during the dry summer season. If a hay crop is desired the second season, the rape is killed by pasturing it closely with sheep during the late fall or winter. Sheep eat off the crowns of the plants close to the ground and the rape then dies. If the rape is not killed it will go to seed the next summer, and the stalks will give some trouble in the hay. If the clover is not cropped too closely the first summer, this method gives an excellent stand.

Failures occur frequently, especially in the Willamette Valley, when clover is sown by any one of the first three methods described. With rich, moist soil of good texture and with frequent rains during the summer these methods are usually successful. But with soils that are inclined to puddle and dry out quickly—soils that have produced grain crops exclusively for a number of years—they often give poor results. Under such conditions the grain shades the clover too much, and robs it of the moisture necessary to carry it through the first summer.

THE SEED CROP.

Since the first crop of clover is seldom used for seed it is cut for hay or ensilage about the 1st of June to enable the second crop to make a good growth before the dry season begins. Instead of cutting the first crop for hay or ensilage, clover is sometimes pastured until late in May, and the first crop is then used for seed. By mowing the first crop, however, the second one comes on more evenly than when the first is pastured.

When the heads of the seed crop are pretty well dried and are dark-brown in color the clover is cut with a self-raking reaper, or with a mower with a buncher attachment. Bunches of the size of an ordinary wheat bundle are dropped in rows. When the heads are dry enough to powder when rubbed in the hands five or six bunches are thrown together by hand or bunched with a hayrake in the morning when damp with dew. The thrashing is done when possible with a clover huller, and the clover is hauled to the machine in tight-bottomed racks in order that the shattered seed may not be lost.

ALSIKE CLOVER.

Alsike clover (*Trifolium hybridum*) has a much wider range of adaptability in western Oregon and western Washington than red clover. It thrives not only on soil adapted to the latter—upland clays and well-drained soils—but also on lowland clays, alluvial bottoms, and many soils too wet and cold to grow red clover. Its stems are much finer and more recumbent than those of red clover, and its leaves are not so numerous. The yield of the first crop is very satisfactory, but it is disposed to make but little growth after a crop has fully matured for hay. If cut early, however, it is said to make a very satisfactory second growth. A delay of only a few days in the time of cutting the first crop makes a very marked difference in the growth of the second.

Alsike clover makes a very good quality of hay and is well suited to sow with timothy, since these two crops mature at the same time. It is a perennial, stands grazing well, and seems to be much less susceptible to the attacks of the clover root borer than is red clover. Since alsike clover is so nearly the equal of red clover in nearly every way it should be given a thorough trial in all localities west of the Cascade Mountains where red clover may have failed.

From what has been said it is evident that alsike clover is eminently adapted for sowing on land that is too cold and wet for red clover, in mixtures for permanent pastures, and on forest burns and burnt slashings that are to be used for pasture for several years.

The seed of alsike clover is quite small and 5 or 6 pounds per acre will be found sufficient when it is sown alone. With this exception,

all that has been said regarding the seeding of red clover applies equally well to alsike clover.

COMMON VETCH.

The common vetch (*Vicia sativa*) is perfectly adapted to conditions west of the Cascade Mountains in Oregon and Washington and thrives even on very poor soil. It has been grown in the Willamette Valley for many years, and is rapidly replacing red clover in many localities. It is an annual legume of great value as a nitrogen gatherer, as a green manure, and as a soiling, hay, and pasture plant. It is also a very valuable cover crop in orchards when sown in the early fall. It makes excellent ensilage, and dairy cattle prefer the hay to that of red clover. The yield of cured hay is from 1½ to 4 tons per acre. A seed crop yields from 15 to 30 bushels per acre, the yield depending quite largely upon the efficiency with which the seed is saved. A bushel of clean seed weighs a little more than 60 pounds.

METHODS OF SOWING.

Common vetch stands the winters admirably in western Oregon and western Washington, and is sown in the autumn from the last of August to the last of November. It is sown also in the early spring, but fall seeding usually gives the largest yields. The stems of this vetch are not strong, and heavy crops are inclined to flatten out on the ground. When in this fallen condition it soon begins to mold and is very difficult to harvest. To furnish support for it and keep it up off the ground a bushel of oats, wheat, or rye, and a bushel of vetch per acre are usually sown together. Oat hay, especially for dairy purposes, is usually preferred to that of wheat or rye, and for this reason oats are usually sown with vetch, winter oats being sown in the fall and spring oats in the spring. It is a common practice with vetch growers to sow winter oats and vetch broadcast in the early fall on land that has raised a spring crop and to cover the seed with a disk harrow. If the land is loose and easily worked, this method gives good results, but like most other crops vetch gives much better yields if sown on a well-prepared seed bed. If the ground is packed, or if the seeding is done in the spring, the land is usually plowed and a good seed bed prepared.

SOILING.

Sown with rye the last of August or early in September, common vetch should be ready for soiling, i. e., feeding green, from April 15 to May 1; sown with winter oats or wheat October 1, it should be ready about May 1; sown with winter oats or wheat in the late fall, it should be ready about June 1; sown with oats in February, it

should be ready about June 15. When cut in the early spring for soiling a second crop may be cut or pastured, or the land may be plowed and planted to some other crop.

THE HAY CROP.

Since fall-sown vetch matures for hay in June and rains are not infrequent at this season of the year it is quite a common practice to pasture it in the early spring—March and April—to keep the growth from becoming so heavy that it will fall before it is cut and to retard its development so that haymaking will occur after the rains are over. If the crop is heavy and falls during bad weather it is best to make ensilage of it immediately.

When the seeds are just appearing in the first pods is usually considered the best time to cut vetch for hay. Some cut it earlier than this, while others allow the first seeds to become pretty well matured. If the crop is not too heavy it may be handled in the ordinary way, but it should be put into cocks before the leaves are dry enough to be broken off during the handling. When very heavy it falls more or less, and usually in some prevailing direction. When in this fallen condition the rear of the sickle bar of the mower is usually raised and the guards tilted down. Sometimes a man follows the mower with a strong pitchfork and when the vetch clogs he sticks the tines of the fork into the ground just behind the sickle bar and pulls the vetch loose.

Others cut vetch in but one direction, the opposite way from that in which it is leaning, driving the mower back idle each trip. Men with forks throw each swath out as it is cut, so that the mower can get through without the vetch clogging on the sickle bar. Another way is to cut a swath and with forks roll it on the uncut vetch; cut another swath and roll the two cut swaths on the uncut vetch; cut again and roll out the three cut swaths. This process forms windrows of three swaths each. (See fig. 1.)

With the vetch fallen in one prevailing direction, others cut one way only, driving the mower in such manner that the fallen vetch will point forward and away from the direction driven at an angle of about 45°. A little experience will enable one to determine the proper angle. When the cutting of a swath is finished the sickle bar is raised and the mower thrown out of gear and driven back on the swath just cut to mash it down and make a path for the shoe of the sickle bar with the wheel of the mower. With the rear of the sickle bar raised, the guards tilted down, the vetch lying in the direction indicated, and the last cut swath lapping up on the uncut vetch and mashed down by driving the empty mower back over it, the inner wheel of the mower, as the next swath is being cut, runs

upon the swath just cut and holds it so that the shoe of the sickle bar slips over with little or no clogging. In this way the swath upon which the wheels of the mower are running is cut in two again and another clean swath is also cut at the same time. Cutting each swath in two twice makes the handling of the hay much easier. After being cut the hay may be cured and handled in the usual way.

THE SEED CROP.

It is very difficult to separate the seeds of wheat or rye from vetch seed, while those of oats and vetch can be separated reasonably well. For a seed crop that is intended for market, therefore, oats and vetch

FIG. 1.—A common method of cutting tangled vetch. The first swath cut is rolled on the uncut vetch; after the mower passes again, the double swath is rolled on the uncut vetch; when the mower has cut under this, the triple swath is rolled outward.

are usually sown together in the early fall—about a bushel of each per acre. In the spring they are usually pastured until April to keep the growth from becoming so rank that it will fall. The vetch then matures in July. The seed matures very unevenly; the pods burst open when overripe and exposed to the sun, and much of the seed may be lost in this way. The best seed is always produced in the lower pods and the seed crop is usually cut when these pods are turning brown and before they have begun to drop their seed.

If the crop stands up well and is not too heavy it is cut with a binder and shocked immediately. From 12 to 15 bundles are put in the bottom of the shock and other bundles built on top of this

again, letting the butts of the upper bundles come down to the bands of the lower ones. Other bundles are built on top of this again, covering all of the seed pods possible. This prevents the shattering of a great deal of seed, for the pods dry evenly and gradually when not exposed to the sun.

If strictly pure seed is desired, vetch is sometimes sown alone at the rate of 100 to 120 pounds per acre. When thick it stands up reasonably well. If the seed crop is too heavy to bind, it is cut with a mower. With pitchforks the first cut swath is rolled on the uncut vetch; another swath is then cut and the two cut swaths rolled on the uncut vetch. When the third swath is cut the three cut swaths are rolled out. This forms windrows of three swaths each. It is then placed in large cocks immediately and allowed to dry with as little exposure to the sun as is possible. This method of cutting and cocking largely prevents the loss of seed from shattering. If cut and raked in the usual way the wheels of the mower, the wheels of the rake, and the tramping of the horses burst many of the ripe pods. As soon as the vetch is dry it should be thrashed without delay with an ordinary thrashing machine, hauling it to the machine in racks with tight bottoms or with canvas spread over the racks to catch the shattered seed. In thrashing, the concaves are removed and blanks having no teeth used instead. The motion of the cylinder is slowed down and plenty of wind turned on. The use of hay caps in curing vetch for seed would greatly increase the yield, especially when it is cut with a mower. The pods on the surface of the cocks become dry and burst before the centers of the cocks have time to cure. In this way a great deal of seed is lost. The caps would protect the pods on the surface of the cock from the direct rays of the sun and permit the whole cock to dry more evenly. (See the discussion of hay caps on p. 11.)

In growing a seed crop of vetch considerable seed is lost on the ground by the bursting of the pods. If this fallen vetch seed is plowed under, much of it will be covered too deeply to germinate. The amount of oil in the seed is such that it may then lie in the ground for years without decaying, and will grow when turned up near the surface by subsequent plowing. In this way it may become a pest in wheat that is grown for market. Land that has grown a seed crop of vetch may be prepared for wheat as follows: Sow oats and vetch broadcast in the fall, without plowing, and cover the seed with a disk harrow. Cut the oats and vetch for hay the next season and pasture the second growth close enough to prevent any seed from maturing. Grow a cultivated crop the next year. The land should then be ready for winter wheat.

PEARL VETCH.

Pearl vetch (*Vicia sativa alba*) has been grown in the Willamette Valley for a number of years, but is comparatively unknown except in the vicinity of New Era, Oreg. It is so much like the common vetch (*Vicia sativa*) that they can not be distinguished except by the color of the seed. The common vetch has a dark-colored, mottled seed, while the seed of pearl vetch is a light salmon color, with a pearly luster. The uses and values of these two plants seem to be identical, with the exception that the seed of pearl vetch, it is claimed, is a good table vegetable, being used particularly in making soup. Its seed probably also makes better feed when chopped. What has been said regarding the uses, culture, and handling of the common vetch applies equally well to pearl vetch.

FIELD PEAS.

Field peas (*Pisum arvense*) are well adapted to the conditions of western Oregon and western Washington. They do well on a large variety of soils, but are especially adapted to clay soils and alluvial bottoms. They are grown for grain, hay, ensilage, and soiling. Peas are nutritious, and the hay and ensilage are eaten with relish by most kinds of stock. When grown for hay about 2 bushels of peas and 2 bushels of oats per acre are sown together as early in the spring as the condition of the ground will permit. When sown at the same time the oats often choke out the peas. This may be largely avoided by sowing the peas first, preferably with a drill, since the seed is difficult to cover, and when they have sprouts on them about 2 inches long drill in the oats. This will give the peas the start and they will hold their own much better. If sown broadcast they should be well covered with a disk harrow. Peas should be cut for hay when the seeds in the first pods are just ready for table use. Sown in the early spring they mature for hay from the 1st to the 15th of July. The yield is from 1½ to 4 tons of hay per acre. When harvested for seed the yield is usually from 25 to 30 bushels per acre. Peas are often sown alone and harvested when mature by swine turned into the field.

The pea weevil often does considerable damage to the pea crop, especially when grown for seed. When sown late, peas suffer much more from the ravages of this pest than they do when sown early. Since they stand considerable frost they should be sown as early in the spring as the season will permit. Of late years peas fail in some localities from other causes than the weevil. They assume a pale, sickly appearance and the yield and quality of the hay are very unsatisfactory. In localities where this happens common vetch and pearl

vetch should be grown instead of peas, for they are sure crops and are equal or even superior to peas in practically every way as a forage plant.

ALFALFA.

At the present time the growing of alfalfa (*Medicago sativa*) west of the Cascade Mountains is only in the experimental stage. Small areas are to be found in various places, some of which are doing reasonably well. Most of these have not been planted long enough and have not been studied sufficiently to justify definite conclusions as to the future usefulness of alfalfa in this region. There are many localities with well-drained soils, however, in which it will unquestionably succeed if given proper treatment. In regions in which the rainfall is as great as it is at certain seasons west of the Cascade Mountains, alfalfa requires a loose, permeable subsoil, and seems to thrive best on the sandy loams along the water courses. The best alfalfa fields noticed were on the sandy alluvial soils on the Willamette and Columbia rivers. The water table of land selected for alfalfa should be at least 4 feet below the surface, and the land should not be subject to overflow. Alfalfa will stand considerable flooding, provided the water is running, but it is usually destroyed if stationary water covers it for a few days.

There are two important difficulties to be overcome in the successful production of alfalfa in this region. In the first place bluegrass, English rye-grass, Italian rye-grass, velvet grass, couch-grass, and many other grasses and weeds have a strong tendency to crowd out the alfalfa. This difficulty is largely overcome by eradicating these plants, so far as possible, before the seeding is done. Thorough disking and harrowing at a time when the alfalfa has made but little growth, or just after cutting a crop of hay, tends to keep it vigorous and holds the weeds and grasses in check. The disk harrow should be weighted to make it cut deep and should be set about as straight as possible, so as not to cut off the crowns of the alfalfa plants. Although these grasses, when growing with alfalfa, actually decrease the total amount of forage produced, they also decrease the danger of bloating when the field is pastured by sheep, goats, or cattle. In fact, grasses are frequently sown with alfalfa for this purpose. Secondly, the first and last crops of alfalfa mature at seasons of the year when it is very difficult to make hay on account of the damp weather. This objection is obviated by using the first and third cuttings for ensilage, soiling, or pasture.

METHODS OF SOWING.

This must be governed largely by local conditions. Land that is naturally well drained or that is tiled at least 3 feet deep should be selected for this crop. If barnyard manure is available, put on from 15 to 20 tons per acre in the fall

and plow it under 8 to 10 inches deep. In the spring, when the land is in good working condition, cut it up thoroughly with a disk harrow and work it down fine. Let it lie for a week or ten days; then give a good harrowing so as to destroy all weeds. Sow about 15 pounds of clean seed per acre and cover with a harrow. If the soil is inclined to be dry, finish with a roller. About the time the seed is sown, put on 75 to 100 pounds of land plaster to the acre.[a]

INOCULATION.

The failure of alfalfa west of the Cascade Mountains is frequently due to the lack of nodule-forming bacteria in the soil. If the land to be sown has never grown alfalfa before, it is the safest plan to artificially introduce these organisms. This may be done in two ways:

(1) From 300 to 500 pounds of soil, the more the better, may be hauled from a field that has recently produced alfalfa with nodules on the roots, and scattered evenly over the surface of the new field. This should be done just before the alfalfa seed is sown and the soil should be thoroughly mixed with that of the new field by harrowing or disking. It is quite expensive to inoculate large fields in this way and there is always a possibility of transferring plant diseases from one field to another.

Of scarcely less importance is the danger of disseminating noxious weeds and insect pests through this plan of inoculating by means of natural soils. Even though weeds may not have been serious in the first field, the great number of dormant seeds requiring but a slight change in surroundings to produce germination is always a menace. If soil is to be used, however, whether obtained from near-by fields or shipped long distances, the evidence should be clear that the soil is free from the objections mentioned above.[b]

(2) Pure cultures of the proper bacteria may be used. The Bureau of Plant Industry of the United States Department of Agriculture has isolated the different organisms for the different legumes, is growing them in pure cultures, and furnishes them to farmers whose soil conditions seem to indicate that inoculation is necessary.

Those desiring inoculating material should write to Soil Bacteriology Investigations, Bureau of Plant Industry, Washington, D. C., for an application blank. To avoid delays, requests should be on file several weeks before the material is to be used.

Should weeds tend to crowd out the alfalfa during the first year, they should be mown often enough to hold them in check. The cutter bar of the mower should be set about 5 inches high in order that the young alfalfa plants may not be cut too closely. If the crop mowed would be sufficient when dry to make a third of a ton or more of hay (and dried weeds) to the acre, which it usually will be in spots, it should be removed from the field; if less than this it may be permitted to lie where it is cut.

[a] Dr. James Withycombe, in Bulletin 76, Oregon Experiment Station.

[b] Farmers' Bulletin No. 240, U. S. Dept. of Agriculture.

The leaves and stems of alfalfa sometimes turn yellow, and the crop then assumes a very unthrifty appearance. When this condition begins to manifest itself the field should be cut immediately, even though the growth be very small. This will tend to invigorate the plants and keep them in a growing condition. If the growth is sufficient the first season, it may be used for either hay or pasture, but under no circumstances should it be closely pastured the first year.

In the moist climate west of the Cascade Mountains it frequently happens that alfalfa sends up young shoots from the crown of the plants before the first growth begins to bloom. When this occurs it should be cut at once; otherwise the first crop soon begins to deteriorate and the second growth will be seriously stunted. In this region it is very essential, therefore, to watch alfalfa closely and cut it as soon as these young shoots begin to appear.

Alfalfa is not a satisfactory pasture crop for cattle or sheep because of its tendency to produce bloat in these animals when they are allowed to graze on it, but for horses and hogs, particularly hogs, there is no better pasture.

TIMOTHY.

Timothy (*Phleum pratense*) is the standard grass in Oregon and Washington west of the Cascade Mountains. It is shallow rooted and naturally adapted to moist lands. But the abundant rainfall of this region, distributed as it is through so many months of the year, makes it possible for it to succeed on practically all classes of soils except the sands and gravels. There are individual farmers who like other grasses better, but timothy is the one grass that is universally known and grown. It has been the standard market hay so long and has so many valuable characteristics that it will require years for any other grass, even with superior qualities, to become as popular as timothy in this region.

There are many reasons why timothy enjoys this popularity. It has the best seed habits of any of our cultivated grasses. The seed is usually cheap, has a very high percentage of germination when properly matured, is easily harvested, and retains its vitality remarkably well. The hay is easily cured, stands handling well, and is relished by all kinds of stock. Unlike many other grasses, a few days' delay in the time of cutting makes but little difference in the quality of the hay—a very important point in a region where showers are not infrequent during the haying season.

West of the Cascade Mountains timothy is most frequently grown with red clover. It is sometimes sown in the fall with winter wheat and the clover added in the spring, during February or March, when the ground is thawing and freezing. Another method is to prepare the ground in the spring and sow the timothy and clover with or

without a nurse crop. Still another way is to sow the clover in the spring with a nurse crop and in September, after the grain has been harvested, sow the timothy on the stubble. When sown with a nurse crop, timothy and clover are shaded too much, especially if the nurse crop is allowed to mature for grain, and unsatisfactory stands are often obtained in this way. Perhaps the most satisfactory way of sowing both timothy and clover is to sow them without a nurse crop in the late summer or early fall on land that is as free as possible from weeds. Good stands are secured in this way, and they give excellent yields the first year. Timothy is two or three weeks later than red clover, and when they are grown together for hay either the timothy must be cut a little immature or the clover allowed to become too ripe. For this reason some other grasses are better suited than timothy for sowing with red clover. When sown alone from 6 to 10 pounds of timothy seed per acre are sufficient. For a seed crop timothy yields much better when the stand is comparatively thin. A much finer quality of hay is produced when it is thick. It is the general rule to cut timothy for hay just at the end of the blooming period. Cattle prefer the hay when cut at this stage, while horses seem to relish it better if it is a little more mature.

THE RYE-GRASSES.

English rye-grass (*Lolium perenne*) and Italian rye-grass (*Lolium italicum*) are more popular on the Pacific coast west of the Cascade Mountains than in any other part of the United States. The moist, mild climate of this region is well adapted to their growth, and they are very popular with the comparatively few farmers who grow them. Stock seem to prefer them to all other grasses, and the herbage they produce is certainly of a very fine quality. The rye-grasses form a close sod and stand cropping and tramping well, but they do not yield so well as some other grasses. They mature early and are well suited to sow with red clover. They are especially adapted to low, moist soils, and when grown under favorable circumstances they may be cut two or three times during a season. Italian rye-grass is practically an annual. The plants do not all die at the end of the first year, but they amount to but little after the first season. Although usually considered a perennial, English rye-grass is short-lived and is very little better than Italian rye-grass in this respect. In England, where these grasses occupy a similar position in agriculture to that of timothy in the United States, it is a common practice to allow seed to mature before they are cut for hay. In this way they reseed themselves and last from year to year. It is claimed also that this is a safe thing to do so far as the quality of the hay is concerned.

The seed of these grasses is usually of good quality and germinates well. It weighs from 14 to 20 pounds per bushel. It may be sown in the spring, but early fall seeding gives the best results in this region. When sown alone from 25 to 40 pounds of seed per acre should give satisfactory stands. The rye-grasses sown with clover make excellent silage.

ORCHARD GRASS.

Orchard grass (*Dactylis glomerata*) thrives remarkably well on all tillable soils west of the Cascade Mountains, except those that are very wet. It is the earliest grass to start to grow in the spring; it revives quickly after it is cropped by stock or cut for hay, especially if the soil is moist; it remains green during the summer and fall, and is relished fairly well by all kinds of stock; it stands grazing and tramping much better than timothy, and lasts for a number of years when given proper care. It is, therefore, eminently adapted for pasture purposes and should form an important part of every permanent pasture mixture.

Orchard grass makes an excellent quality of hay if cut before or just after the blooming period. If the cutting is delayed but a few days beyond this period orchard grass has a strong tendency to become woody, and the hay is then of poor quality. It ripens with red clover, and under favorable circumstances it may be cut twice during a season. It is, therefore, especially well fitted for sowing with red clover when intended for hay. It grows in bunches and does not make a smooth sod; for this reason it is seldom sown alone. Orchard grass is a little early, and is often ready to cut before good haying weather has begun. This fact and its tendency to become woody immediately after blooming are the chief drawbacks to its culture west of the Cascade Mountains. Its earliness is an advantage, however, when it is used for ensilage or soiling.

The seed habits of orchard grass are very satisfactory, and the yield is from 15 to 18 bushels of seed per acre. The seed weighs from 14 to 18 pounds per bushel. When sown alone 20 to 25 pounds of seed per acre will be sufficient. It is sown either in the fall or spring. If sown in the early fall, without a nurse crop, it should make an excellent crop the next year.

MEADOW FESCUE.

Although meadow fescue (*Festuca pratensis*) is grown but little west of the Cascade Mountains, it is highly prized by those who know it. Like orchard grass, it is adapted to practically all of the tillable soils of the region except those that are gravelly or very wet. It is a perennial; lasts much better than timothy; is relished by all

kinds of stock; makes a good quality of hay; and, when once established, stands tramping and grazing well. It does not begin to grow so early in the spring as orchard grass, but remains green during the summer and makes a good growth during the fall. It is especially adapted to a place in meadow and pasture mixtures that are to occupy the land for a number of years. One of the leading dairymen of the Willamette Valley sows the following mixture in the spring: Meadow fescue, 10 pounds; English rye-grass, 10 pounds; timothy, 4 pounds; red clover, 4 pounds, and alsike clover, 2 pounds. This mixture is used for hay for two years, and then for pasture three years. Of the grasses in this mixture, meadow fescue is his favorite.

Meadow fescue may be sown in the early fall or spring. When sown alone, from 15 to 20 pounds per acre of the best seed should be used. If the quality of the seed is doubtful, sow more. Kansas farmers who grow their own seed sow only 12 to 15 pounds per acre.

VELVET GRASS.

The only part of the United States in which velvet grass occurs to an extent worthy of notice is on the Pacific coast west of the Cascade Mountains, from northern California to the Canadian line. In that section it is indifferently called velvet grass and mesquite. The latter name should never be applied to this grass, as it is used for several other very different grasses in the Southwest.

It is generally regarded as a pest on the Pacific coast, particularly on lands that are very wet in winter and very dry in summer. This is especially the case with both sandy and peaty soils on the coast. It is not utilized for feed in many localities, but on the extensive areas of sandy land around the mouth of the Columbia River and at one or two points inland it is the chief reliance, both for hay and pasture. It yields ordinarily about half a ton of hay per acre. The hay is remarkable for its lightness, a ton of it being much more bulky than a like weight of other kinds of hay. Horses nearly starve before they acquire a taste for velvet grass, but when the taste is once acquired they thrive upon it remarkably well, showing that it is highly nutritious. The whole plant is covered by a growth of wool-like hairs, from which fact the name is derived. It is unworthy of attention except on the classes of soils above mentioned. On these soils it drives out all other grasses.[a]

Velvet grass (*Holcus lanatus*) is frequently a pest in meadows. The seed matures very early, is light, and shatters readily. When clover, rye-grass, and timothy are ready to cut for hay the seed of velvet grass is usually mature enough to germinate. The wind blows the seed, and wherever the hay is hauled or handled the seed is scattered. If a meadow that is infested with velvet grass is cut a little early for either hay or ensilage, the seed can not be spread in this way. Velvet grass gives no trouble in the second crop of clover. Fence rows and waste places beside meadows should be mown early

[a] W. J. Spillman, in "Farm Grasses of the United States."

enough to prevent seed from maturing. If these precautions are taken the grass can be prevented from becoming very troublesome.

To eradicate velvet grass cut it early, before the seed is ripe, generally from the 10th to the 20th of June. About the 1st of July give it a thorough but shallow disking. Repeat the shallow disking every week until the 1st of August and then spring-tooth and disk again. This shallow cultivation during the driest season will kill the roots and leave the ground with a very fine mulch on top and plenty of moisture in the subsoil. The land may then be reseeded to clover or planted to any crop desired.[a]

INDIAN CORN.

The climatic conditions of western Oregon and western Washington are not well adapted to the growing of corn (*Zea mays*). The nights are too cool for its best development, and unless very early varieties are grown difficulty is often experienced in bringing it to maturity. Nevertheless corn fills an important place in the cropping systems of this region, particularly on dairy farms; i. e., for ensilage and for feeding green during August, September, and October. While it may be impracticable to grow corn for the grain, it is possible by selecting very early varieties and using seed grown near by to grow a good quality of ensilage corn. The aim should be to grow those varieties that reach as near maturity and yield as much grain as possible. The large southern varieties produce very little grain here, and are so immature when put into the silo at the end of the season that too much acid develops.

The following table gives the quantity of water and dry matter in corn at different stages of growth, as determined by the New York (Geneva) Agricultural Experiment Station:

Water and dry matter in corn at different periods after tasseling.

Date of cutting.	Stage of growth.	Corn per acre.	Water per acre.	Dry matter per acre.
		Tons.	*Tons.*	*Tons.*
July 30	Fully tasseled	9.0	8.2	0.8
Aug. 9	Fully silked	12.9	11.3	1.5
Aug. 21	Kernels watery to full milk	16.3	14.0	2.3
Sept. 7	Kernels glazing	16.1	12.5	3.6
Sept. 23	Ripe	14.2	10.2	4.0

This table is very interesting. The last column shows the dry matter of corn at different stages of growth. Ripe corn yields five times as much dry matter per acre as corn that is fully tasseled, two and two-thirds times as much as corn fully silked, and nearly one and three-fourths times as much as corn in the milk; hence, the importance of growing corn for ensilage that will mature. The

[a] Letter from W. H. Kaufman, Bellingham, Wash.

table also shows the great waste in feeding corn green instead of letting it mature properly and making it into ensilage.

In order that ensilage may keep well, corn should be cut about the time the kernels are well glazed and dented. If it is cut too green, as stated, too much acid develops; if cut too ripe it does not settle properly and the air is not sufficiently excluded to prevent spoiling. The ripest corn should always be cut first and placed in the bottom of the silo, because the great pressure near the bottom will tend to exclude the air.

If planted on rich, mellow, well-drained land between the middle of May and the first of June, corn should be ready for feeding green from about the 1st to the 15th of August. As previously stated early varieties should be planted, and seed grown west of the Cascade Mountains succeeds better than eastern seed.

RAPE.

Rape (*Brassica napus*) has been grown in the Willamette Valley with excellent results for twenty years. It is a succulent, nutritious forage plant, admirably adapted to the moist, mild climate of the Pacific coast. It stands considerable freezing, and is seldom winter-killed west of the Cascade Mountains. It does best on deep, warm, well-manured loamy soils. It succeeds well also on peaty soils, but is not adapted to very light sandy or heavy clay soils. It is a heavy feeder, and must not be expected to succeed on poor, worn-out land.

Rape is an excellent crop for pasture or soiling, i. e., for cutting and feeding green for hogs, sheep, goats, and poultry. Fed to dairy cows it causes a large flow of milk, but to avoid tainting the milk it should be fed immediately after milking, at the rate of 30 to 50 pounds per day, in two feeds. On account of danger of bloating, sheep, goats, and cattle should never be turned on rape for the first time when they are hungry, or when the rape is wet with dew or rain. They should have plenty of something else to eat first, and plenty of salt at all times. It is a good plan to give them access to hay or a grass pasture to prevent overloading on rape. When sheep have become accustomed to it they may be left on it continually with but little danger.

Rape is grown and utilized west of the Cascade Mountains in several different ways:

(1) When grown for early summer use, the largest yields and the best results are secured by making a succession of plantings at intervals of two or three weeks, beginning in the early spring as soon as the ground can be put into perfect tilth. The ground should be well manured and the seed planted in drills 24 to 36 inches apart at the rate of about 2 pounds per acre. A common garden drill may be used

in planting small areas, but for larger fields a grain drill, with some of the feed hoppers closed to make the rows the desired distance apart, answers the purpose best. As soon as the plants are sufficiently large they should be cultivated often enough to control the weeds and keep the soil in good tilth. The cultivation will retain the soil moisture and tend to keep the plants growing vigorously. Unless cultivated during the dry portion of summer, growth almost ceases until the fall rains come. Rape grown in this way may be used either for pasture or for soiling.

When rape is used for soiling purposes it should be cut at least 5 inches high, so that the plants will have a chance to grow again. In from six to eight weeks after planting it should be large enough to cut; by making a succession of plantings green, succulent feed should be on hand throughout the summer. If rape is used for pasture, the best results will be secured by having a number of small fields which are pastured alternately. It may be fed in this way also by means of movable fences. Rape should be from 12 to 14 inches high before it is used for pasture, and hogs should be prevented from rooting while in the field. When rape is removed by cutting or pasturing closely, the evaporation of soil moisture is rapid, and it should be cultivated as soon as possible if a second growth is desired. If sown in drills, stock will walk between the rows while feeding, and much less will be broken down and destroyed than if they were feeding upon rape that was sown broadcast. A larger yield is also secured by planting rape in rows and cultivating it.

(2) Another favorite way of growing rape is to sow it broadcast at intervals in the spring. The land is plowed and thoroughly worked in the early spring, as soon as it is in good working condition, and then allowed to lie until the seeding is done. Just before each piece is sown the ground is cultivated thoroughly again and from 3 to 4 pounds of seed sown and covered with a harrow or cultivator. Instead of sowing the seed broadcast it is sometimes planted with a common grain drill. Rape sown the 1st of May should be ready for pasture the 1st of July; if sown the 1st of June, it should be ready for pasture by the 1st of August. Grown in this way rape makes excellent pasture during the summer, fall, and early winter.

(3) Another method of raising rape that is popular with many farmers, especially those who raise sheep or goats, is to grow it with clover. The method of doing this has already been fully described in the discussion of red clover (page 16).

(4) Rape is sometimes sown with oats in the spring on a thoroughly prepared seed bed. The oats are used for either hay or grain. The rape grows but little until the early fall rains come, after which it is soon ready for pasture. From 2 to 4 pounds of rape seed per acre are sufficient when sown in this way.

(5) From 3 to 4 pounds of rape seed per acre are also sown with corn just before the last cultivation. The seed is then covered by the cultivator and the rape comes on and makes good pasture as soon as the corn is harvested. It may also be sown with potatoes, but it does not succeed so well with them as with corn, for the digging of the potatoes destroys much of the rape. Sown after early potatoes are dug, it gives good pasture during the late fall and early winter.

THE SEED CROP.

Good rape seed is now produced in the Willamette Valley and the region about Puget Sound, and there is no reason why farmers should not produce their own seed. Rape is a biennial and does not produce seed when sown in the spring until the second year. If sown in September or October it matures seed the following June. Rape may be cross-fertilized by kale, cauliflower, and other closely related plants. It is believed to cross also with wild mustard and wild turnips; hence none of these plants should be allowed to grow near rape that is intended for seed.

For seed, rape should be sown alone, and it is very desirable to have in it drills in order to cultivate it and keep it free from the plants mentioned. Rape that is planted in drills in the spring may be used for soiling during the summer and fall, carried through the winter, and used for a seed crop the second season. If sown entirely for a seed crop, it may be planted in the fall—September or October—after some early crop has been removed. To retard development of the plants so that the seed will mature after the late spring rains are over, it should be pastured or cut back about the last of April or the first of May. If ripe rape gets wet the seed shatters very readily, and the retardation of the development of the crop is often very necessary in order to have good weather for harvesting the seed.

Rape should be cut for seed when the first seeds are turning brown. It may be cut with a binder or a self-raking reaper. It should be shocked in such manner that it will dry out quickly. Birds destroy considerable of the seed; hence it should be thrashed as soon as dry. If the crop is not too extensive a man with a team and sled may drive from shock to shock and thrash it by hand. If a thrashing machine is used, it should be hauled to the machine in tight-bottomed racks, or canvas should be spread over the racks to catch the shattered seed. It is said that a yield of 1,000 pounds of seed to the acre is not unusual in the Willamette Valley.

Seed may be purchased of local seedsmen. When buying seed, however, one should always call for Dwarf Essex rape. There are a number of varieties of rape, some of which are annuals and are grown only for bird seed. If these annuals are sown in the spring

they produce seed the same year and are liable to become serious pests when once introduced. Complaint has been made that Dwarf Essex rape becomes a weed, but it is easily controlled. It does not produce seed until the second season, and if plowed under during the fall, winter, or spring no seed can be produced.

THOUSAND-HEADED KALE.

Thousand-headed kale (*Brassica oleracea*) has been grown in the Willamette Valley for 27 years. It attracted little attention among the dairymen until recent years, but is now rapidly becoming a very popular fall and winter soiling crop. It stands the mild winters

FIG. 2.—A field of thousand-headed kale on Martins Island, near Kalama, Wash. A valuable winter soiling crop, available from October 1 to April 1.

west of the Cascade Mountains admirably and is hauled from the field and fed as needed. It does not head up like cabbage, and the name "thousand-headed" is given it on account of the numerous branches the plants have when given plenty of room. It is very much like rape, but the plants are much taller and the leaves are longer and broader. A field of this crop is shown in figure 2. It is claimed that kale will yield 30 to 40 tons of green feed per acre when grown under favorable conditions.

Kale is used for table greens, but its chief use on the Pacific coast is for feeding green to dairy cows from October to April, for which it is highly prized. It would undoubtedly be an excellent winter

feed also for hogs and poultry. It does best on well-manured, deep, rich loams and sandy soils. The only objection to the use of kale is the difficulty of getting it out of the field when the ground is wet and muddy. For this reason well-drained land should be selected upon which to plant this crop.

METHODS OF SOWING.

For fall and winter use, kale is usually sown in drills on well-prepared and well-drained soil as soon after the 15th of March as the season will permit. This furnishes plants for transplanting in June and July. The land used for transplanting is well manured and plowed two or three times between the 1st of March and the 1st of June. With the land in perfect tilth it is plowed again with a 12-inch plow about the 1st of June and the young kale plants dropped into every third furrow about 2½ to 3 feet apart. This places about one plant on every square yard. The roots of the plants are placed where the next furrow covers them, leaving the tops uncovered. The plants that are plowed in during the day in this way are rolled in the evening of the same day to pack the ground. Two or three cultivations are all that can usually be given, for the plants will soon touch in the row if they do well. Any plants that fail to grow may be replaced by hand. Some growers prefer to plant the seed in hills, and when the plants are large enough thin them to one plant in a hill. Others put kale out just as cabbage is usually transplanted, instead of plowing it in. The time of transplanting must be determined by the size of the plants and the condition of the land. If the land is wet and subject to overflow the transplanting may be delayed until during July. If the land is well drained and the plants are large enough it may be done before the 1st of June. In transplanting, enough plants may be left for a stand on the land where the seedlings are grown.

FEEDING.

As previously stated, kale stands in the field during the winter and is hauled in and fed green as needed from about the 1st of October to the 1st of April. If the growth is forced in the early spring it can be fed much earlier than the 1st of October. To avoid tainting the milk, kale is fed just after milking, at the rate of 25 to 50 pounds per day, in two feeds. Some let it wilt before feeding. Enough may be hauled in at a time to last four or five days. It should not be thrown into heaps and allowed to heat. Neither should it be fed when frozen. On the approach of freezing weather a supply sufficient to last several days may be placed in the barn.

To haul kale from the field during wet weather it is best to wear a gum coat and gum boots. The plants can then be cut off at the sur-

face of the ground with an ax, thrown into piles, and loaded on a wagon with a pitchfork without serious inconvenience to the worker.

Kale grows a great deal during the fall and winter, and much is lost by feeding the whole plant in the early part of the feeding season. By using only the lower leaves it is possible to begin feeding quite early without stopping the growth of the plants. With the thumb and fingers of the hand extended, one can break off all of the lower leaves of a large plant with three or four downward strokes of the hand. This is not practicable, however, during damp weather, for the leaves would be too wet to handle in this manner.

THE SEED CROP.

An excellent quality of kale seed is produced in the Willamette Valley. Like rape, it is a biennial and does not produce seed until the second year. Richard Scott, a dairyman of the Willamette Valley, has grown kale for twenty-seven years. He produces seed about as follows: There is considerable variation in the types of individual plants. During the first year plants with many rather narrow leaves that begin spreading from near the surface of the ground are selected. This type of plant yields more and stands freezing better than a plant the stem of which is bare for some distance above the ground. These selected plants are transplanted in February in some isolated place to prevent cross-fertilization by undesirable kale plants, rape, cauliflower, and other closely related plants. It is believed that kale crosses with wild mustard and wild turnip; hence none of these plants should be allowed to grow near kale that is intended for seed. The seed crop is cut when the first seeds are turning brown. If the crop is small, it is usually thrashed by hand. A large crop may be handled the same as a seed crop of rape. Birds are fond of the seed, and for this reason it should remain in the field only until dry.

ROOT CROPS.

Since the soil requirements and the methods of culture of mangel-wurzels (*Beta vulgaris* var. *macrorhiza*), carrots (*Daucus carota*), and ruta-bagas (*Brassica campestris*) are very similar, they will be treated collectively. Like rape and thousand-headed kale, they succeed best where the weather is moist and cool. Hence their eminent adaptation to western Oregon and Washington. In this region the yield of these crops is enormous, the ordinary yield being from 20 to 35 tons per acre, while reports of 45 or 50 tons are not infrequent.

Root crops usually succeed best on deep, moist, friable loam soils. On clay land they grow too slowly, and the soil is also difficult to work. Ordinarily, land for roots is heavily manured in the fall and then plowed considerably deeper than for other crops. If the soil runs

together badly during the winter, it is replowed in the early spring. Instead of the above procedure, the manure is sometimes spread during the winter, the land plowed deep in the early spring, and a fine, firm seed bed formed immediately by disking, harrowing, rolling, planking, etc., as the conditions may require. Between the preparation of the seed bed in the early spring and planting the seed during April or early in May the land is cultivated sufficiently to keep the weeds subdued. Just before planting the seed a thorough cultivation is given, finishing with a planker or clod masher. This destroys the weeds, thoroughly pulverizes the soil, and leaves the surface smooth and in good condition for planting.

Mangel-wurzels and ruta-bagas are usually grown in rows from 22 to 30 inches apart. When planted in continuous rows, enough seed is used to insure a good stand. When sown with a hill-dropping planter, the hills are from 8 to 15 inches apart and 4 or 5 seeds are dropped in each hill. The rows of carrots are usually 18 inches apart and the hills 8 inches.

FIG. 3.—A "scuffle" hoe devised and used by W. J. Langdon, Sumner, Wash., in thinning and weeding root crops. A very effective implement.

As soon as the plants can be seen in the rows, the wheel hoe is started. With the guards of the hoe next to the row, the cultivation is done as close to the row as possible without covering or disturbing the plants too much. Considerable hand weeding and hoeing between the hills and along the rows is usually necessary. When the plants are 3 or 4 inches high, they are thinned, leaving the most vigorous plant in each hill. When sown in continuous rows, the thinning is largely done with a hoe, striking across the row. Subsequent cultivation should at least be sufficient to keep the weeds under control. As much of it as possible is usually done with a horse cultivator.

Instead of the common and wheel hoes for thinning and weeding, some prefer to use a "scuffle" hoe. (See figs. 3 and 4.) When in use, the blade of such hoes is in a horizontal position and is pushed and pulled just under the surface of the ground. The blade shown in figure 3 is diamond shaped, about 2 inches wide in the middle and one-half inch wide at each end, and about 8 inches long. About an

inch of the tip of one end is turned up at a right angle to form a guard for working close to small plants. The blade of the hoe should be sharp on both edges, so that it will cut each way when pushed and pulled. In order to make it take hold properly, it may be necessary to bend the edges of the blade down slightly. To give the handle the proper angle, the shank should be curved. It should flatten out into a narrow, thin plate about 2 inches long and fasten to the blade by means of two rivets. This hoe is not on the market, but may be made by any blacksmith. An old saw makes excellent blades. The shank should be made of Norway iron, so that it may be bent to give the handle the proper angle.

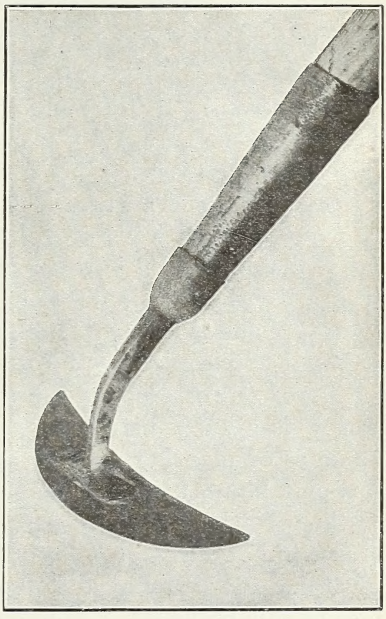

FIG. 4.—A "scuffle" hoe similar in principle to that shown in figure 3, devised by A. B. Leckenby, Seattle, Wash. The blade of either of these hoes may be made from an old saw blade.

Ruta-bagas are sometimes sown in drills in the early spring and transplanted like cabbage. The plants may be transplanted like kale, as the land is plowed. The roots of the plants are placed where the next furrow will cover them and the tops are left sticking out. For this method of transplanting, see the discussion of kale.

About the 1st of November the roots are topped, pulled, and placed in narrow bins in the barn. Upon the approach of cold weather they are covered with hay or straw. The tops are sometimes cut off with a sharp hoe and the roots then dug with a potato fork. More generally they are dug first, the worker pulling on the top of the root with one hand as he bears down upon the handle of the potato fork with the other. The roots of two or three rows are laid together with the tops one way. The tops are then cut off with a long-handled knife. Some twist the tops off, claiming that the roots do not bleed and wither so much as they do when the tops are cut off. Roots are grown mostly for winter use and are fed up to the 1st of April. They are generally sliced before being fed to dairy cattle. Some dairymen feed them whole, claiming that cows can handle large roots nicely and that, unless the slicing is carefully done, they do not choke so frequently when feeding on whole roots as they do on sliced roots.

The flat or fall turnip (*Brassica rapa*) is also grown in western Oregon and Washington. Since it matures quickly, grows mostly above ground, and has a flesh less firm than that of other roots it does not keep well and is adapted only to fall and early winter use. Its soft flesh and habit of growth above ground make it an admirable root to be harvested by stock turned into the field. It is usually sown broadcast on clean land about the 1st of July. It may be sown also in corn. If intended for winter use it should be gathered and put into bins before becoming water-soaked from fall rains.

SOILING (GREEN FEEDING) CROPS.

The mild winter climate and abundant rainfall of western Oregon and Washington make it almost an ideal region for the production of soiling crops. By the judicious selection and planting of crops green succulent food may be provided for the dairy cow during practically the entire year. That a much greater amount of feed can be obtained from the same area of land by this system as compared with pasturing is a fact well recognized by progressive dairymen. Much of the tillable land of this region is now very valuable. As values advance beyond the limit where farm land may profitably be used for pasture and it becomes necessary for the small farmer to keep the maximum number of stock upon his few acres of tillable land, the growing of soiling crops becomes of vital importance.

Below is given a list of the crops that are used for this purpose. The dates of planting and the approximate dates upon which these crops may be used are also given. It must be understood, however, that the variation in seasons prevents one from saying definitely when a crop will be ready to use. For further information regarding these crops the reader is referred to the discussion of each in the preceding pages of this bulletin.

Dates for planting and using soiling crops in western Oregon and western Washington.

Crops.	When planted.	When used.
Rye and vetch	September 1 to 15	April 1 to May 15.
Winter oats and vetch	September and October	May 15 to July 1.
Winter wheat and vetch	do	Do.
Red clover		Do.
Alfalfa		During June.
Oats and peas	February	Do.
Oats and vetch	do	June 15 to July 15.
Oats and peas	April	During July.
Rape	May 1	Do.
Oats and peas	May	During August.
Rape	June	Do.
Corn	May 10 to 20	During August, September, and October.
Turnips	July 1	Late fall and early winter.
Thousand-headed kale	March 15 and transplanted June 1.	October 15 to April 1.
Mangel-wurzels, carrots, and ruta-bagas	April	October 15 to April 1 (fed from bins, pits, or root houses).

SEEDING TIMBER BURNS AND BURNT SLASHINGS.

As previously stated, dense forests of evergreen timber cover a very large portion of western Oregon and western Washington. During the dry season of the year forest fires overrun large areas, killing practically all vegetation, and leaving a loose blanket of ashes on the surface of the ground. These burnt areas if left unmolested for a few years usually produce a dense growth of young trees and brush and are practically worthless for grazing purposes. In clearing land it also frequently happens that the timber and brush are slashed and burnt several years before the stumps are removed. By properly seeding these burnt areas they may be made to produce excellent pasture. Since the stumps are in the ground and there is therefore no chance to cover the seed, the seeding should always be done in the fall before the ashes have settled. The first rain that comes will then cover the seed sufficiently to insure good germination.

Since there is little chance to improve or renew the stand on account of the stumps and timber remaining on the land, only seed of those plants should be sown that last a long time, stand close cropping, and yet produce as much growth as possible. If the seed is sown in the unsettled ashes as indicated, little difficulty will be experienced in getting good stands of white clover, alsike clover, red clover, orchard grass, meadow fescue, timothy, and English rye-grass. A mixture of 1 pound of white clover, 3 pounds of alsike clover, 10 of orchard grass, and 10 pounds of meadow fescue per acre should give satisfactory results when sown in the unsettled ashes in the early fall. Timothy will also do well for this purpose. Red clover and English rye-grass are each short-lived and should form but a small portion of the mixture, if sown at all. Timber burns that have been seeded down in this way should be pastured pretty closely to keep down the young trees and brush. Goats will help to do this better than any other kind of animal. The success of seeding burnt areas in this way has been thoroughly demonstrated in many parts of the region. It is only a question of sowing the proper seed at the proper time.